LOCOMOTIVES of 1906

CHAS. S. LAKE.

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PERCIVAL MARSHALL & CO. LONDON. E.C.

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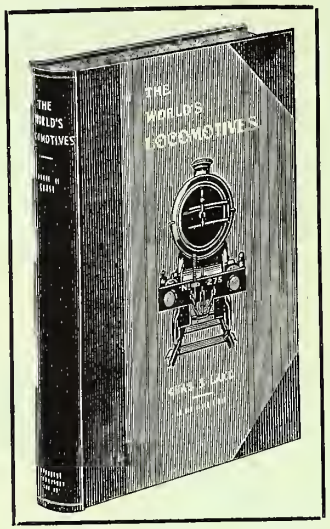
PERCIVAL MARSHALL & CO., 26-29, Poppin's Court, Fleet Street, London, E.C.

THE WORLD'S LOCOMOTIVES.

By CHAS. S. LAKE.



THIS is absolutely the finest and most complete work on modern locomotives yet published. No expense has been spared in the preparation and production of this handsome volume.

It is not intended as a text book on locomotive design, but aims at showing in a concise and interesting fashion the steps taken by locomotive engineers and builders to cope with the increasing traffic requirements of modern times. All classes of locomotives, from the heaviest express and goods engines to the smallest light railway engines, are illustrated and described, and an easily understood system of classification is adopted and adhered to throughout. The book is the outcome of a long experience of the subject on the part of the author, who for several years past has, under exceptionally favourable circumstances, been making a close study of the best modern locomotive practice. He has been courteously and freely assisted by locomotive engineers in all parts of the world, and, where possible, the dimensions and other particulars given in the book have been checked by the actual designers of the engines referred to. This volume forms a reference book which should be of the greatest possible value to all who are engaged in locomotive designing, building, or using. A strong feature is the large number of photographs of modern engines, and the numerous detail drawings of special features of design.

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LOCOMOTIVES
OF
1906.

By CHAS. S. LAKE.

Author of "The World's Locomotives," "The Locomotive Simply Explained."

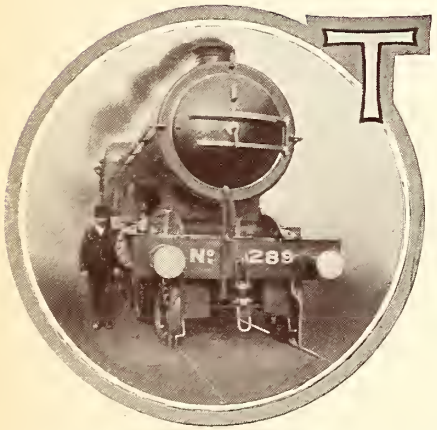
London :
PERCIVAL MARSHALL & CO., 26-29, POPPIN'S COURT, FLEET STREET, E.C.

PUBLISHERS' NOTE.

THE present volume, although complete in itself, is issued chiefly with the purpose of continuing the excellent survey of modern locomotive practice provided by Mr. Chas. S. Lake in his well-known work "THE WORLD'S LOCOMOTIVES." The exhaustive and very accurate information presented by Mr. Lake in that book has secured for it a reputation and an importance as a reference book for locomotive men which is possessed by no other publication, and it has therefore been felt desirable that it should be supplemented from time to time by further notes in the same style, on the more recent engines, both in this country and abroad. Those possessing the original work will thus have a convenient and inexpensive means of keeping it fully up-to-date.

LOCOMOTIVES OF 1906.

By CHAS. S. LAKE.



THE year 1906 will always rank as a noteworthy one in the annals of the world's locomotive practice; for not only was it productive of several innovations connected with that branch of engineering, but, in addition, material progress was made in developing the size and power of locomotives belonging to what, in present times, are recognised as standard types. A little more than one hundred years have now elapsed since the first railway locomotive was constructed,* and, although it is no part of the author's intention to revert, in this publication, to matters of locomotive history, it is, nevertheless, interesting to recall the fact that, whereas the earliest engines weighed only some four or five tons in working order, there are to be found among the largest of modern British types those which, complete and in full running condition, turn the scale at from 120 to 130 tons, whilst even these figures are considerably exceeded abroad, and especially so in the United States.

In these later times there are many who would have us believe that the days of the steam locomotive are numbered, that indeed the fate of this type of motor is already sealed, and that the passing of 1906 marked yet another milestone very far advanced along the road to obsolescence for such engines, the while electricity as a motive power continues its triumphant progress towards general adoption for all classes of railway traffic. With a large percentage of these the wish is, no doubt, father to the thought, but for those who have made a careful study of railway operative conditions, including the all-important financial aspect of the question, there can be but one opinion, namely, that the universal adoption of electric traction for railway purposes is still a very long way off; certain as it would

*Trevithick's engine of 1803.

appear that the final solution of this very complex problem will be found in the substitution of some other form of motive power—most probably electricity—for that of steam.

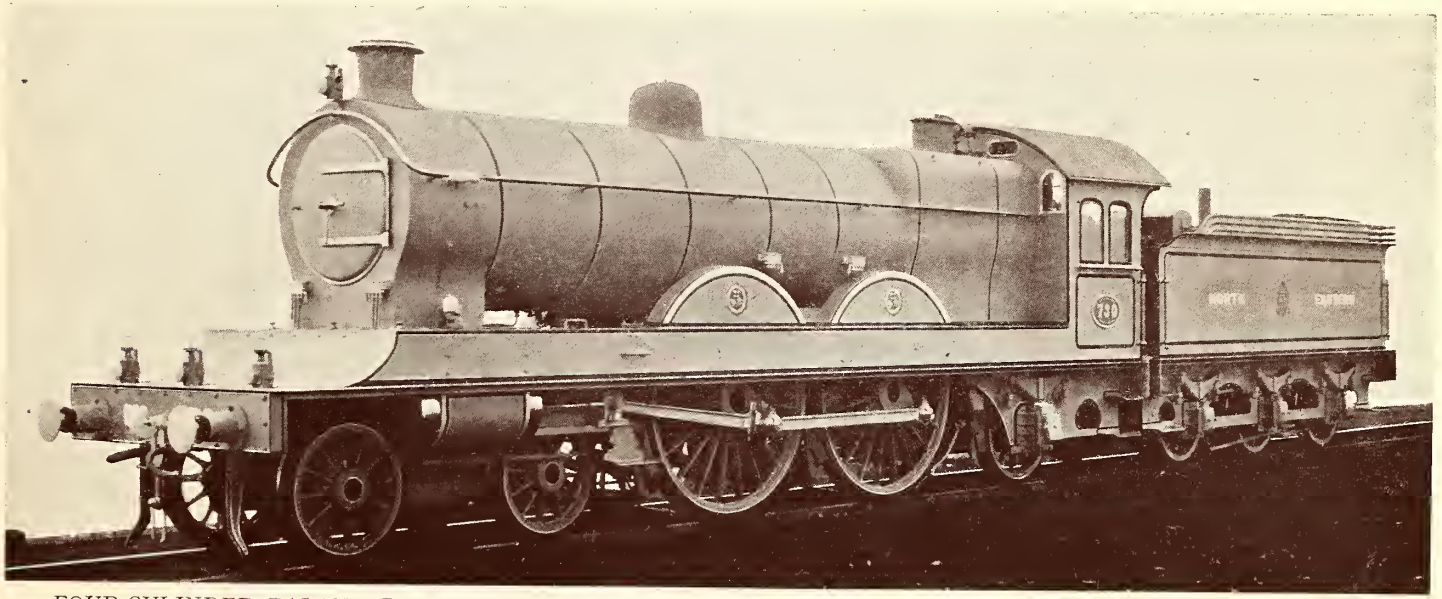
The wider application of electric traction on railways, as distinct from its universal adoption, is, of course, inevitable, but for all that, the disappearance of the steam locomotive will be a very gradual process, and no one can pretend to determine the period which will have elapsed before it has become possible to travel, say, from London to Aberdeen, by electrically propelled trains.

Even where suburban and local traffic is in question, railway companies have shown themselves by no means over-anxious to resort to electrical haulage so long as the traffic can be profitably worked by steam power; the cost of transformation being such a very serious consideration. The extended use which is being made of rail motor-cars has some bearing upon the point, although, of course, the principal object in adopting these cars is to reduce as much as possible empty mileage of trains on suburban and short distance services generally.

The main objection raised against increasing the size and power of suburban tank locomotives is that, in order to obtain the additional adhesion required, the designer must perforce employ a greater number of coupled wheels, and, as a natural consequence of this, the drawback of a long rigid wheelbase is introduced. Against this we have to remember that by adopting the articulated form of locomotive it is possible to secure all the adhesion force which can be desired, whilst at the same time keeping the rigid wheelbase down to minimum proportions. Of course, articulated locomotives are more expensive to build and maintain than ordinary ones, but the difference is not to be compared with that involved in converting a line from steam to electricity.

If anything were required to emphasise the vitality of the steam locomotive at the present time, there is the fact that during 1906 one of the most important Committees ever formed in the history of engineering passed designs for no fewer than ten different types of locomotives, which, for the future, are to be considered as standards on the railways of our great dependency—India. Moreover, locomotive engineers throughout the world are striving as deliberately as ever to effect further improvements in their designs, both from a collective point of view and also in respect of details, knowing full well that much yet remains to be accomplished before the present form of locomotive is finally abandoned. *Festina lente*—this is perforce a question which time will largely decide.

The credit for progress in locomotive matters during 1906 belongs to no one country more than another. On our own side the locomotive engineers of the North-Eastern and Great Western Railways introduced on their respective lines engines of a type hitherto untried thereon. Mr. Wilson Worsdell, M.Inst.C.E., Chief



FOUR-CYLINDER BALANCED COMPOUND EXPRESS LOCOMOTIVE (4—4—2 TYPE), NORTH-EASTERN RAILWAY.

MR. WILSON WORSDELL, M.Inst.C.E., *Chief Mechanical Engineer*, GATESHEAD.

Leading Particulars.

Cylinders: Diameter, H.-P., 14¼ ins.; L.-P., 22 ins.; piston stroke, 26 ins.
Bogie wheels diameter, 3 ft. 7¼ ins.
Coupled wheels diameter, 7 ft. 1¼ ins.
Trailing wheels diameter, 4 ft.
Wheelbase: Bogie, 6 ft. 6 ins.; coupled, 7 ft. 6 ins.; total (engine) wheelbase, 28 ft. 9 ins.
Boiler: Diameter, 5 ft. outside; length between tube plates, 15 ft.; centre height above rails, 8 ft. 10 ins.
Heating surface: Tubes, 1,782 sq. ft.; firebox, 180 sq. ft.: total heating surface, 1,962 sq. ft.
Grate area, 29 sq. ft.
Steam pressure, 225 lbs. per sq. in.
Weight on coupled wheels, 39 tons 3 cwt.; weight of engine in working order, 73 tons 12 cwt.
Capacity of tender, 3,800 gallons of water and 5 tons of coal.
Total weight of engine and tender in working order, 116 tons 4 cwt.
Tractive force, 17,539 lbs.

Mechanical Engineer of the first-named railway, brought out two new four-cylinder balanced compound locomotives of the "Atlantic" (4—4—2) type, and one of these is illustrated on page 5. The cylinders in these engines are arranged in line below the smokebox, all driving the leading pair of coupled wheels. Only two sets of valve gear are employed for actuating the steam distributing valves for each pair of cylinders, and the Belpaire type of firebox is introduced for the first time in these engines on the North-Eastern Railway. Of the two locomotives so far built, one (No. 731) is fitted with modified Walschaerts valve gear, and the other has Stephenson link-motion also in a modified form. The engines were designed for hauling, as between York and Edinburgh, the heaviest and fastest East Coast Anglo-Scottish express trains, and very successful results are being obtained from their use on this important traffic.

On the Great Western Railway, the locomotive engineer, Mr. G. J. Churchward, M.Inst.C.E., introduced what is, strictly speaking, an entirely new design of locomotive. In this he employs the "Atlantic" or 4—4—2 wheel arrangement and four single-expansion cylinders, located two inside and two outside the frames, driving separate coupled axles. The inside cylinders are placed well forward, over the leading bogie axle, and drive the front coupled (crank) axle, while the outside cylinders are at the rear of the bogie centre and these drive the second pair of coupled wheels, thus distributing the work done on the pistons over two axles instead of one, and, as only two sets of valve gear are employed for actuating the four valves, it follows that the number of moving parts is reduced to the minimum for a four-cylinder divided engine. The boiler is of the new standard type adopted at Swindon; it is coned throughout the entire length of the barrel, and is fitted with the Belpaire type of firebox. Engines of this description are very rapid starters, and their ability to accelerate heavy trains is one of the chief points in their favour. A further number of these engines has been ordered by the Great Western Railway directors, and the same cylinder arrangement is to be applied to locomotives of the 4—6—0 type. Probably by the time this is in print some of the engines will have been completed at Swindon and placed in regular service.

Apart from the question of cylinder disposition, it has to be recorded that during 1906 the 4—4—2 type of locomotive came into further prominence on British railways, and for the first time it has found its way on to a Scottish line—viz., the North British. Prior to that, the only "Atlantic" engines ever seen in Scotland were those belonging to the North-Eastern which run over the North British Company's system between Berwick and Edinburgh (Waverley). These, however, are, of course, only to be regarded as "foreigners," and it was not until Mr. W. P. Reid, locomotive engineer of the North British Railway, brought out in July last the engines of the class illustrated on page 9 that the "Atlantic" type of engine became directly associated

FOUR-CYLINDER (SIMPLE) EXPRESS LOCOMOTIVE (4—4—2 TYPE), GREAT WESTERN RAILWAY.

MR. G. JACKSON CHURCHWARD, M.Inst.C.E., *Locomotive Superintendent*, SWINDON.

Leading Particulars.

Cylinders : Diameter, $14\frac{1}{4}$ ins. ; piston stroke, 26 ins.
Bogie wheels diameter, 3 ft. 2 ins.
Coupled wheels diameter, 6 ft. $8\frac{1}{2}$ ins.
Trailing wheels diameter, 4 ft. $1\frac{1}{2}$ ins.
Wheelbase : Bogie, 7 ft. ; coupled, 7 ft. ; total (engine), 27 ft. 9 ins.
Boiler : Diameter at front end, 4 ft. $10\frac{3}{4}$ ins. ; diameter at firebox end, 5 ft. 6 ins. ; length between tube plates, 15 ft. $2\frac{3}{16}$ ins. ; centre height above rail level, 8 ft. 6 ins.
Heating surface : Tubes (250), 1988·65 sq. ft. ; firebox, 154·26 sq. ft. : total heating surface, 2142·91 sq. ft.
Grate area, 27·07 sq. ft.
Working pressure, 225 lbs. per sq. in.
Weight on coupled wheels, 39 tons 12 cwts. ; weight of engine in working order, 74 tons 10 cwts.
Capacity of tender, 3,500 gallons of water and 6 tons of coal.
Total weight of engine and tender in working order, 114 tons 10 cwts.
Tractive force, 26,560 lbs.

with the locomotive practice of Scotland. In this design there are two simple cylinders placed outside the frames between the bogie wheels, and the second pair of coupled wheels are the drivers. The valve gear is of the ordinary link-motion type inside the frames. A very large boiler with Belpaire firebox is fitted, the centre line being placed very nearly 9 ft. above the level of the rails, with the result that the chimney and mountings have been reduced to what may be considered as the minimum practicable dimensions.

This is another instance in which the Belpaire firebox has been introduced for the first time on a particular railway. Mr. Reid's design ought to prove successful, for in it he combines such essentials as an ample cylinder capacity, an adhesion load which must be regarded as about the maximum for a four-wheels-coupled engine, abundant heating surface and grate area, and a high working steam pressure. We have, therefore, all the principal factors necessary for obtaining satisfactory working results, and that without having recourse to any multiplication of parts. The engines are engaged in hauling heavy express trains over the North British sections of the East Coast and Waverley routes to Aberdeen ; they present a very fine appearance at the head of the new corridor trains built for this traffic simultaneously with the introduction of the "Atlantic" locomotives.

A very similar engine to that last described, but with somewhat smaller over-all proportions, was introduced by Mr. D. Earle Marsh, M.Inst.C.E., locomotive superintendent of the London, Brighton and South Coast Railway. This very handsome and effective design, illustrated on page 11, follows in many important respects that of Mr. Ivatt's 251 class engines of the 4—4—2 type on the Great Northern Railway. It has the short total wheelbase and wide firebox of the last-named engines, and other characteristics common to both designs are the somewhat restricted cylinder dimensions employed in conjunction with a large total heating surface and grate area. One might be pardoned for doubting whether such large engines as these are really needed on a line like the "Brighton," but a course of footplate trips with the heaviest express trains, especially those comprising the Portsmouth traffic, quickly dispel any questioning upon the point.

The locomotives of this class were built to a very careful specification by Messrs. Kitson & Co., Ltd., of Leeds, and the workmanship and finish alike bear striking testimony to the high standard which has been reached among British locomotive builders.

The number of 4—4—2 type express passenger locomotives in use on the Great Central Railway was largely increased during 1906, and this Company had, at the time of writing, some thirty engines of that description in service. Four of them are compounded with three cylinders—viz., one high-pressure between the frames, and two low-pressure outside. The cylinders are

"ATLANTIC" (4—4—2 TYPE) EXPRESS LOCOMOTIVE, NORTH BRITISH RAILWAY.
MR. W. P. REID, M.I.Mech.E., *Locomotive Superintendent*, COWLAIRS.

Leading Particulars.

Cylinders: Diameter, 20 ins.; piston stroke, 28 ins.
Bogie wheels diameter, 3 ft. 6 ins.
Coupled wheels diameter, 6 ft. 9 ins.
Trailing wheels diameter, 4 ft. 3 ins.
Wheelbase: Bogie, 6 ft. 6 ins.; coupled, 7 ft. 3 ins.; total (engine) wheelbase, 27 ft. 9½ ins.
Boiler: Diameter (outside), 5 ft. 6 ins.; length between tube plates, 15 ft.

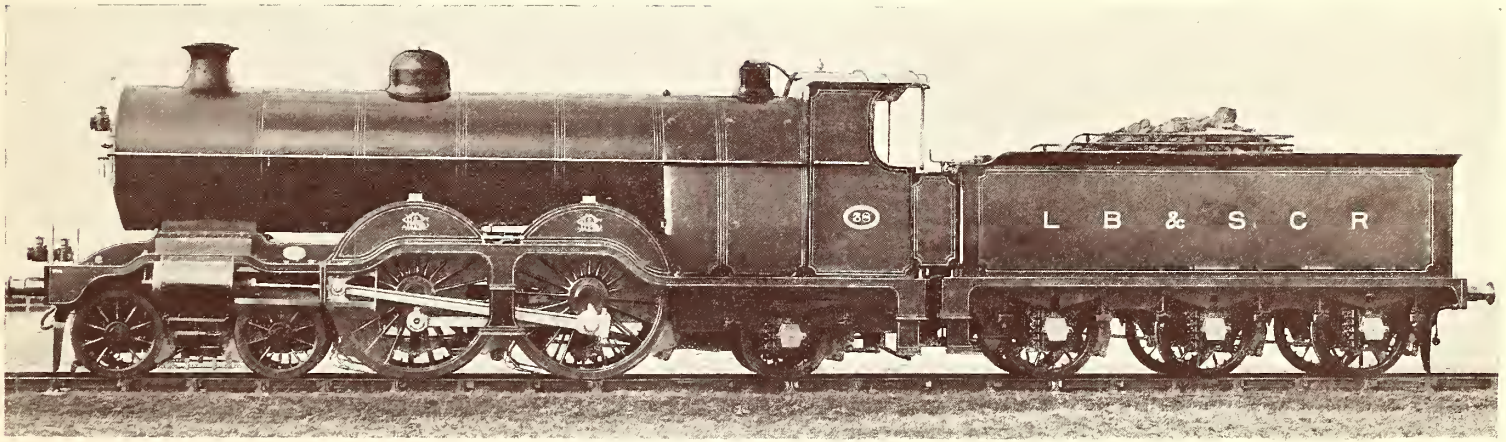
Heating surface: Tubes, 2,071·4 sq. ft.; firebox, 184·8 sq. ft.: total, 2256·2 sq. ft.
Grate area, 28·5 sq. ft.
Working pressure, 200 lbs. per sq. in.
Weight on coupled wheels, 40 tons; weight of engine in working order, 74 tons, 8 cwt.
Capacity of tender: For water, 4,240 gallons; for coal, 7 tons.
Total weight of engine and tender in working order, 119 tons 16 cwt.

Tractive force, 22,123 lbs.

arranged in line below the smokebox with the inside (high-pressure) cylinder driving the crank axle of the leading coupled wheels and the outside (low-pressure) cylinders actuating crank-pins in the second pair of coupled wheels. The engines are arranged for working either compound or semi-compound at the will of the driver. The design is beautifully proportioned; indeed it has been said of these engines that they are the "handsomest 'Atlantics' in the country." Whatever view one may take on this point, it is certain that in them Mr. J. G. Robinson, M.Inst.C.E., chief mechanical engineer of the Great Central Railway, has produced a very efficient type of locomotive, and that, after all, is the primary consideration. The only difference noticeable externally between the compounds and non-compounds of this series is the presence of the reducing valve on the right-hand side of the smokebox in the case of the compounds, as shown in the illustration of engine No. 258, on page 13. Several locomotives of the 4—6—0 type were added in 1906 to those already in use on the Great Central Railway. These engines are similar in many important respects to the 4—4—2 type simple engines on the same railway, except of course that they have six instead of four coupled wheels. They are among the most successful 4—6—0 type locomotives in this country. The latest express engines of this design have coupled wheels 6 ft. 6 ins. diameter, against the 6 ft. 9 ins. of the other Great Central Railway six-coupled express locomotives. It is one of the 6-ft. 6-in. class, viz., No. 1,097, "Immingham," that is shown on page 15.

The use of three-cylinder compound locomotives was extended on the Midland Railway during the past year, but in this case the 4—4—0 wheel arrangement has been adhered to, whilst introducing certain improvements in the general design. The cylinders are arranged similarly to those of the Great Central engine previously referred to, but instead of driving separate axles they all actuate the leading coupled wheels, otherwise the system of operation may be regarded as substantially the same in both cases. The Midland engines are engaged in hauling the principal express traffic of that line, and are giving very satisfactory results in doing so. A number of the 7-ft. 4—4—0 type express passenger locomotives of Mr. S. W. Johnson's design on this railway were rebuilt in the course of the year with much larger boilers than those originally fitted. The total heating surface has been increased from 1,205 sq. ft. to 1427·9 sq. ft., the grate area from 19·5 sq. ft. to 21·1 sq. ft., and the working pressure from 160 to 175 lbs. per sq. in. The engines in their rebuilt form are upwards of five tons heavier than before. The new type of cab has been added.

Another new series of 4—4—0 type locomotives was built at the Ashford Works of the South-Eastern and Chatham Railway in 1906 from the designs of Mr. H. S. Wainwright, M.Inst.C.E., locomotive superintendent. The general arrangement of the engines is similar to those



"ATLANTIC" (4—4—2 TYPE) EXPRESS LOCOMOTIVE, LONDON, BRIGHTON AND SOUTH COAST RAILWAY.
MR. D. EARLE MARSH, M.Inst.C.E., *Locomotive Superintendent*, BRIGHTON.

Leading Particulars.

Cylinders: Diameter, 18½ ins.; piston stroke, 26 ins.
Bogie wheels diameter, 3 ft. 6 ins.
Coupled wheels diameter, 6 ft. 7½ ins.
Trailing wheels diameter, 3 ft. 6 ins.
Wheelbase: Bogie, 6 ft. 3 ins.; coupled, 6 ft. 10 ins.; total (engine) wheelbase, 26 ft. 4 ins.
Boiler: Diameter (outside), 5 ft. 6 ins.; length, 16 ft. 3⅞ ins.; centre height, 8 ft. 8½ ins.
Heating surface: Tubes, 2318·3 sq. ft.; firebox, 141 sq. ft.: total heating surface, 2459·3 sq. ft.
Grate area, 31 sq. ft.
Working pressure, 200 lbs. per sq. in.
Weight on coupled wheels, 37 tons 15 cwts.; weight of engine in working order, 67 tons.
Capacity of tender: For water, 3,500 gallons; for coal, 4 tons.
Total weight of engine and tender in working order, 106 tons 10 cwts.
Tractive force, 20,477 lbs.

of the same type which preceded them on this railway, but slightly larger boilers fitted with Belpaire fireboxes are employed. This design is a good example of modern British practice for the 4—4—0 type of simple locomotive.

On the Great Eastern Railway, Mr. James Holden, M.Inst.C.E., locomotive superintendent, rebuilt a further number of the erstwhile "standard" 2—4—0 locomotives, converting them in the process to engines of the 4—4—0 type and providing them with much larger (Belpaire) boilers. As now running, the engines have had their efficiency largely increased.

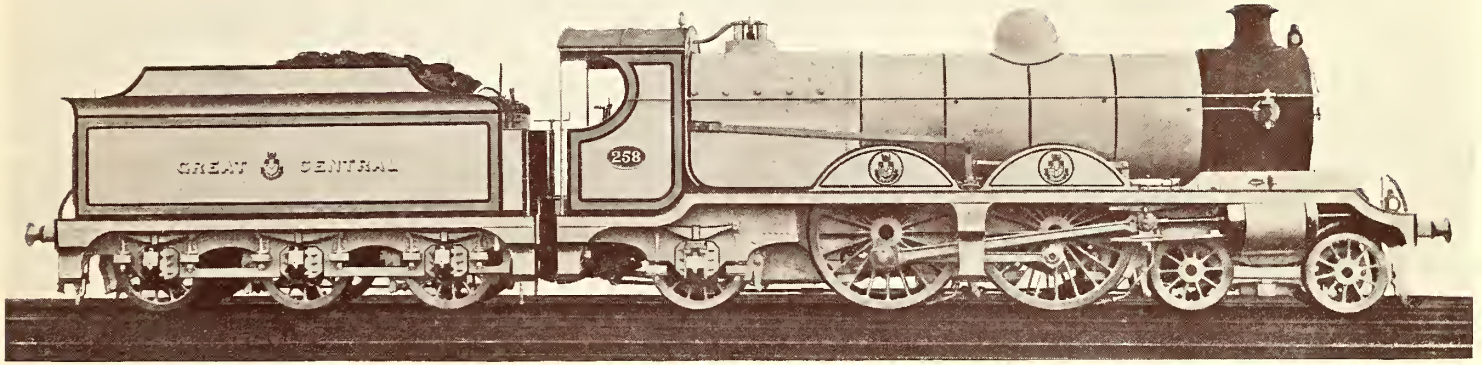
Some new and powerful fast goods engines of the 4—6—0 type were added to the locomotive equipment of the Great Southern and Western Railway (Ireland) in the early part of last year, and later two classes of engines of similar construction were put into service on the Caledonian Railway. Inside cylinders are employed in all cases, but whereas the Caledonian engines have the axle of the foremost coupled wheels cranked and used for driving purposes, in the Great Southern and Western locomotives the intermediate wheels are the drivers.

CALEDONIAN RAILWAY 4—6—0 TYPE MIXED TRAFFIC LOCOMOTIVE.
(Mr. J. T. McIntosh, M.Inst.C.E., *Engineer*, St. Rollox.)

Cylinders, 19 by 26 ins. Coupled wheels, 5 ft. 9 ins. Total heating surface, 2,178 sq. ft. Grate area, 21 sq. ft. Weight of engine, 64 tons. Working pressure, 180 lbs.

Both arrangements have their advantages, and it is for the designer to choose as to which best suits his purpose. Some engineers much prefer to have the cylinders placed horizontally or nearly so, and in that event, with inside cylinders and the 4—6—0 wheel arrangement, it becomes obligatory to drive on the leading coupled axle, but, by suitably inclining the cylinders and driving the middle coupled wheels, it is possible to bring about a reduction of engine wheel-base, and that, of course, is a very desirable thing, especially on certain lines, where curves have to be frequently negotiated. These new engines of the Great Southern and Western and Caledonian Railways are fitted for working with continuous brakes to allow of their being employed on passenger traffic when needed, and their general design is, of course, admirably suited to this purpose.

The large four-cylinder simple passenger locomotives of the 4—6—0 type, designed by Mr. Dugald Drummond, M.Inst.C.E., chief mechanical engineer of the London and South-Western Railway, and built at that Company's Works, Nine Elms, towards the end of 1905,

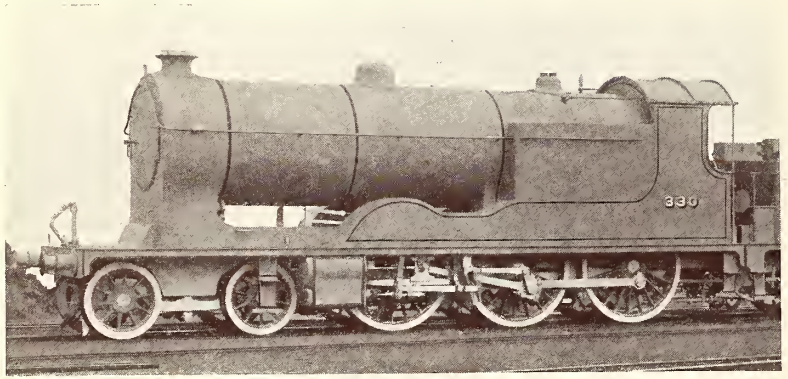


THREE-CYLINDER BALANCED COMPOUND EXPRESS LOCOMOTIVE (4—4—2 TYPE), GREAT CENTRAL RAILWAY.
MR. J. G. ROBINSON, M.Inst.C.E., *Chief Mechanical Engineer*, GORTON.

Leading Particulars.

Cylinders : H.-P. (1), diameter, 19 ins. ; L.-P. (2), diameter, 21 ins. ; piston stroke, 26 ins.
Bogie wheels diameter, 3 ft. 6 ins.
Coupled wheels, 6 ft. 9 ins.
Trailing wheels, 4 ft. 3 ins.
Wheelbase : Bogie, 6 ft. 6 ins. ; coupled, 7 ft. 3 ins. ; total (engine) wheelbase, 27 ft. 9½ ins.
Boiler : Diameter outside (maximum), 5 ft. ; length, 15 ft. ; centre height, 8 ft. 6 ins.
Heating surface : Tubes, 1,778 sq. ft. ; firebox, 153 sq. ft. : total heating surface, 1,931 sq. ft.
Grate area, 26 sq. ft.
Working pressure, 200 lbs. per sq. in.
Weight on coupled wheels, 37 tons.
Total (engine) weight in working order, 71 tons.
Capacity of tender : For water, 4,000 gallons ; for coal, 5 tons.
Total weight of engine and tender in working order, 115 tons 3 cwts.
Tractive force, 16,880 lbs.

may rightly be regarded as belonging to the locomotive developments of 1906, for it was not until the middle of the latter year that they were placed in regular service. They represent a very great advance in English standards of construction, and are equipped with special devices calculated to increase the efficiency of the boiler. These consist of a spark arresting and fuel economising device in the smokebox, cross-water tubes in the firebox, and feed-water heating apparatus in the tender. The boiler is fed by a pair of duplex feed pumps placed vertically just in front of the firebox, one behind the other, and midway between the frames. Injectors are not employed at all in this design, their use being rendered impracticable owing to the fact that the temperature of the feed-water is raised, by the heating apparatus mentioned above, to 180° before it enters the boilers. One pair of cylinders is placed forward under the smokebox between the frames, and the other pair at the rear of the bogie outside the frames, the two groups being respectively arranged for driving the first and second pair of coupled wheels. The outside cylinders have Walschaerts valve gear, and the inside ones ordinary link-motion. The engines are very quick at starting, and with their large cylinder capacity and six coupled wheels of moderate size are, of course, able to deal with enormous train loads.



FOUR-CYLINDER (SIMPLE) 4—6—0 TYPE LOCOMOTIVE, L. & S.W. RLY.
(Mr. D. Drummond, M.Inst.C.E., *Engineer*, Nine Elms.)

Cylinders, 16 by 26 ins. Coupled wheels, 6 ft. Total heating surface, 2,727 sq. ft. Weight in working order, 73 tons. Working pressure, 175 lbs.

Upon the Great Western, London and North-Western, and London, Brighton and South Coast Railways, new tank engines of the 4—4—2 type were introduced during the year 1906. In the first-named instance the design was prepared in the previous year (1905), but the initial engine of the series was not completed until the spring of 1906.

The cylinders have the relatively small diameter and long piston stroke now standard for engines with outside cylinders only on the Great Western Railway, and the coned type of boiler is also fitted. Several of these engines have now been built, and they are used for working fast passenger traffic over distances limited by

4—6—0 TYPE PASSENGER LOCOMOTIVE, GREAT CENTRAL RAILWAY.

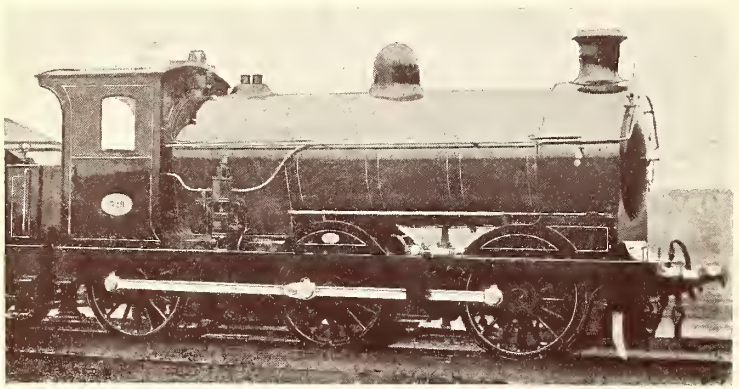
Mr. J. G. Robinson, M.Inst.C.E., *Chief Mechanical Engineer*, Gorton.

Leading Particulars.

Cylinders : Diameter, 19½ ins. ; piston stroke, 26 ins.
Bogie wheels diameter, 3 ft. 6 ins.
Coupled wheels diameter, 6 ft. 6 ins.
Wheelbase : Bogie, 6 ft. 6 ins. ; coupled, 14 ft. 6 ins. ; total (engine) wheelbase, 26 ft. 9½ ins.
Boiler : Diameter (outside), 5 ft., max. ; length, 15 ft. ; centre height, 8 ft. 6 ins. from rail level.
Heating surface : Tubes, 1777·9 sq. ft. ; firebox, 133·1 sq. ft. ; total heating surface, 1,911 sq. ft.
Grate area, 26 sq. ft.
Working pressure, 200 lbs. per sq. in.
Weight on coupled wheels, 54 tons 10 cwts. ; weight of engine in working order, 70 tons 10 cwts.
Capacity of tender : For water, 4,000 gallons ; for coal, 5 tons.
Total weight of engine and tender in working order, 108 tons 1 cwt.
Tractive force, 21,500 lbs.

the coal-carrying capacity of the bunkers. Virtually they are a repetition of the "County" class express locomotives (4—4—0 type) on the Great Western, with side tanks, bunker, and trailing carrying wheels added.

The 4—4—2 type tank engines of the London and North-Western Railway (page 29) are very large machines. They present a substantial and at the same time a neat and symmetrical appearance, conforming in general outline so far as is possible to the "Precursor" express locomotives designed by Mr. George Whale, M.Inst.C.E., chief mechanical engineer. The new tank engines are employed for working heavy local and suburban traffic in the London and Manchester districts, and their use is being extended to other large London and North-Western Railway centres. New engines of the standard 4—4—0 and 4—6—0 types were also added on this railway during 1906.



NORTH BRITISH RAILWAY SIX-COUPLED GOODS LOCOMOTIVE.
(Mr. W. P. Reid, M.I.Mech.E., *Engineer*, Cowlairs.)

Cylinders, 18½ by 26 ins. Coupled wheels, 5 ft. diameter. Heating surface, 1,794 sq. ft. Grate area, 19·25 sq. ft. Weight of engine, 48¾ tons.

The London, Brighton and South Coast Railway tank engines of the 4—4—2 type resemble very closely those of the same description on the Great Northern Railway. They have the same general arrangement and also very similar proportions. Their introduction gives the London, Brighton and South Coast Railway another new type of locomotive, and one, moreover, of a very useful kind.

Several of the British railway Companies increased their stock of eight-wheels-coupled mineral locomotives during 1906, and one line, the Hull and Barnsley, ordered engines of this description for the first time. The Great Western built some further "Consolidation" 2—8—0 type engines, and Mr. Whale, on the London and North-Western, proceeded with his conversion of the four-cylinder 0–8–0 type Webb compounds, altering them to engines of the 2—8—0 type, as shown on page 30.

In addition to this, a number of three-cylinder compound eight-coupled locomotives, built by Mr. Webb, were converted into two-cylinder simple engines without any alteration in the wheelbase. In their rebuilt condition both series are brought into line with the most recent standards.

EXPRESS LOCOMOTIVE (4—4—0 TYPE), SOUTH EASTERN AND CHATHAM RAILWAYS.
MR. H. S. WAINWRIGHT, M.Inst.C.E., *Locomotive Engineer*, ASHFORD.

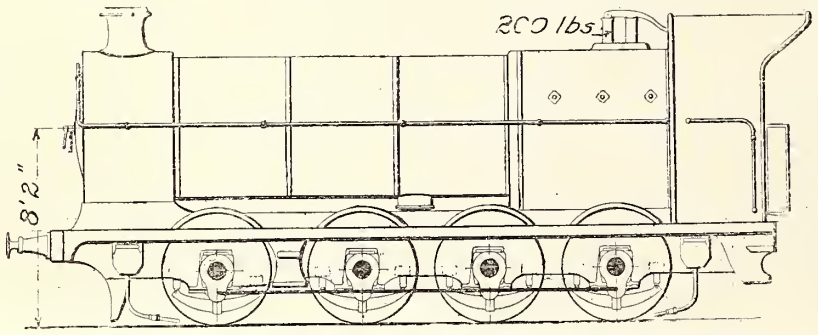
Leading Particulars.

Cylinders : Diameter, 19¼ ins. ; piston stroke, 26 ins.
Bogie wheels diameter, 3 ft. 6 ins.
Coupled wheels diameter, 6 ft. 6 ins.
Wheelbase : Bogie, 6 ft. 3 ins. ; coupled, 9 ft. 6 ins. ; total (engine) wheelbase, 23 ft. 5½ ins.
Boiler : Maximum diameter (outside), 4 ft. 9 ins. ; length, 11 ft. 1 ins. ; centre height, 8 ft.
Heating surface : Tubes, 1,396 sq. ft. ; firebox, 136 sq. ft. ; total heating surface, 1,532 sq. ft.
Firebox, 7 ft. long outside ; grate area, 21·15 sq. ft.
Working pressure, 180 lbs. per sq. in.
Weight on coupled wheels, 34 tons 18 cwts. ; weight of engine in working order, 52 tons 5 cwts. ; weight of engine and tender complete in working order, with 3,450 gallons of water and 4 tons of coal, 91 tons 7 cwts.
Tractive force at 80 per cent. boiler pressure, 17,786 lbs.

A notable locomotive "conversion" of the year was that which transformed the celebrated "Decapod" tank engine of 1903 into an eight-wheels-coupled (0—8—0 type) tender engine on the Great Eastern Railway. This locomotive as reconstructed left Stratford Works in October, and is now regularly working heavy goods trains on the Great Eastern Railway main line. The design has been completely metamorphosed and nothing outwardly remains to suggest that this is indeed the monster tank engine which caused such widespread attention in locomotive circles upwards of four years ago.

New engines of the 0—6—0 type were introduced on the London, Brighton and South Coast and North British Railways (see pages 16 & 32). In both cases the design conforms to the usual ideas for engines of this description on British railways.

On page 33 will be found an illustration of a 4—4—0 type 5-ft. 6-in. gauge passenger locomotive, built by Messrs. Beyer, Peacock & Co., Ltd., of Gorton, for the North-Western Railway of India. Special interest attaches to this design, as it conforms in all respects with the recommendations of the Engineering Standards Committee, and therefore represents standard practice for this class of engine on Indian railways for the future. Except for the presence of the cab on the tender and the sliding shutters instead of windows on the engine cab, the design is typical in every way of modern 4—4—0 type locomotive practice in England, and the dimensions, but for the width, are also similar. The boiler is of the Belpaire type and carries a working pressure of 180 lbs. per sq. in. The design, taken collectively, is a nicely-proportioned one, well adapted to the purpose for which it was prepared.



HULL AND BARNSLEY RAILWAY, 0—8—0 TYPE GOODS LOCOMOTIVE.
(Mr. Matthew Stirling, M.Inst.C.E., *Engineer*.)
Builders: Yorkshire Engine Company, Ltd.

Cylinders, 19 by 26 ins. Wheels, 4 ft. 6 ins. diameter. Total heating surface, 1,859 sq. ft. Grate area, 22 sq. ft.

Foreign locomotive practice during 1906 was characterised, like that of Great Britain, by many notable developments. New types of engines were introduced, and the tendency to increase the size and power of existing standards was well maintained. Some very large locomotives were put to work both in Germany and France, and in all cases the use of four compound cylinders was resorted to. Indeed, it may be said with

THREE-CYLINDER COMPOUND EXPRESS PASSENGER LOCOMOTIVE, MIDLAND RAILWAY.
MR. R. M. DEELEY, M.Inst.C.E., *Locomotive Superintendent*, DERBY.

Leading Particulars.

Cylinders : H.-P. (1), diameter, 19 ins. ; L.-P. (2), diameter, 21 ins. ; piston stroke, 26 ins.
Bogie wheels diameter, 3 ft. 6½ ins.
Coupled wheels diameter, 7 ft.
Wheelbase : Bogie, 6 ft. 6 ins. ; coupled, 9 ft. 6 ins. ; total (engine) wheelbase, 24 ft. 3 ins.
Boiler : Maximum diameter (outside), 4 ft. 9⅛ ins. ; length of barrel, 11 ft. 11 ins. ; centre height, 8 ft. 6 ins.
Heating surface : Tubes, 1305·5 sq. ft. ; firebox, 152·8 sq. ft. : total heating surface, 1458·3 sq. ft.
Grate area, 28·4 sq. ft.
Working pressure, 220 lbs. per sq. in.
Weight on coupled wheels, 39 tons 2 cwts. ; weight of engine in working order, 59 tons 16 cwts.
Capacity of tender : For water, 3,500 gallons ; for coal, 7 tons.
Total weight of engine and tender in working order with 4 tons of coal, 102 tons 14½ cwts.
Tractive force, 21,560 lbs.

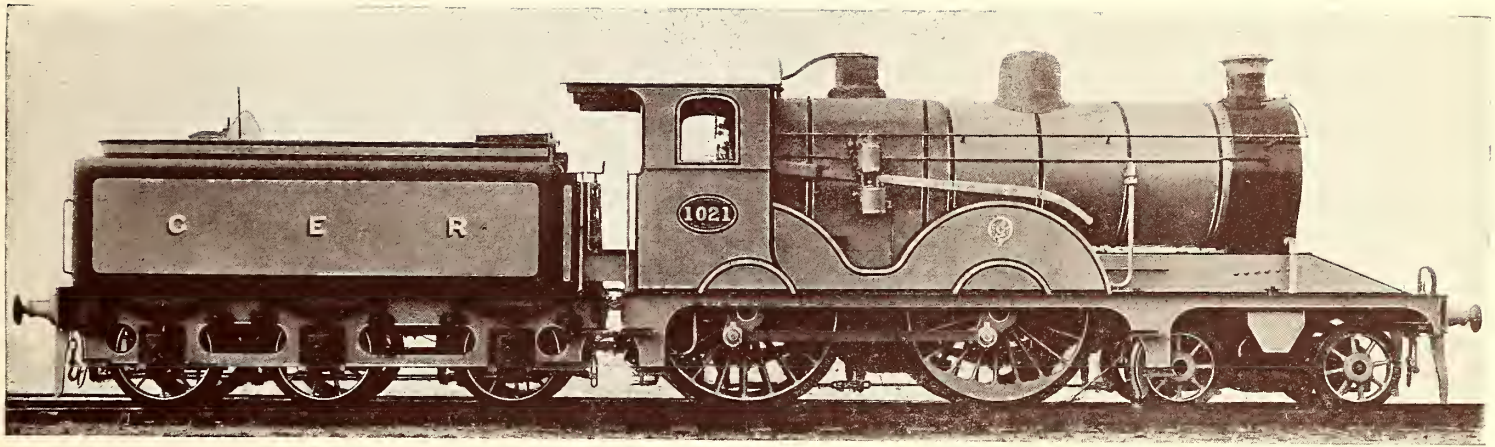
increasing truth that the four-cylinder compound, in one form or another, has now become the standard design of locomotive in foreign countries, and especially is this the case in France, where the de Glehn compound system forms the basis of design for practically all the larger classes of engines. A few examples of foreign locomotives, built during 1906, will be found on pages 34 to 37.

The Bavarian 4—4—4 type locomotive, illustrated on page 34, is an example from the latest German practice. The engine has its cylinders arranged in line below the smokebox all driving the leading coupled wheels; two sets of valve gearing only are provided for the four cylinders, and the bar type of main framing is employed. The front sheets of the cab, and also boiler mountings and smokebox door, are arranged on the "wind cutter" principle for the purpose of reducing the effect of air resistance; wheel splashers are omitted, and everything possible is done to render the moving parts easy of access in all positions of the engine. The boiler, which is of large proportions, is fitted with a superheater of the "Schmidt" type. A large eight-wheeled double-bogie tender is provided. This engine, which was exhibited at Nürnberg Exhibition, was designed specially for hauling passenger trains at a speed of 94 miles per hour on the State Railways of Bavaria.

The latest type of locomotive introduced for express passenger traffic on the Hungarian State Railways is illustrated on page 35. This engine, with others of the same design, was built for high speed passenger service, principally between Vienna and Buda-Pesth. The cylinder and valve arrangements are the same as those of the Bavarian locomotive last described. A notable feature of the Hungarian engine is the cylindrical bogie tender fitted. This is of the Vanderbilt type which originated in America. The engines were built at the State Railway Works, Buda-Pesth, and the first of the series was exhibited at the Milan Exhibition.

An entirely new type of locomotive was introduced on the Austrian State Railways during 1906. This has the 2—10—0 wheel arrangement, and is compounded on Gölsdorf's system, with four cylinders. The engine was designed for hauling heavy passenger trains over the Arlberg division, where previously a large amount of piloting had been necessary, but which has now been done away with as a result of the introduction of this exceedingly powerful type of engine. The cylinders are arranged in line below the smokebox with the high-pressure between and the low-pressure outside the frames; the middle pair of coupled wheels are the drivers. The large cylinder capacity and adhesion weight, in conjunction with the ample boiler power provided, renders the design admirably suited to the conditions of service with which the engine has to deal. An illustration with dimensions will be found on page 36.

Among the latest engines introduced in France are



OIL-BURNING EXPRESS PASSENGER LOCOMOTIVE, GREAT EASTERN RAILWAY.

(Converted from 2—4—0 Type in 1906.)

Mr. James Holden, M.Inst.C.E., *Locomotive Engineer*, Stratford.

Leading Particulars.

Cylinders: Diameter, 18 ins.; piston stroke, 24 ins.

Bogie wheels diameter, 3 ft. 1 in.

Coupled wheels diameter, 7 ft.

Wheelbase: Bogie, 6 ft. 6 ins.; coupled, 8 ft. 9 ins.; total (engine) wheelbase, 21 ft. 4½ ins.

Boiler: Diameter of barrel (outside), 4 ft. 8 ins.; length between tube plates, 10 ft. 4 ins.

Grate area, 21·6 sq. ft.

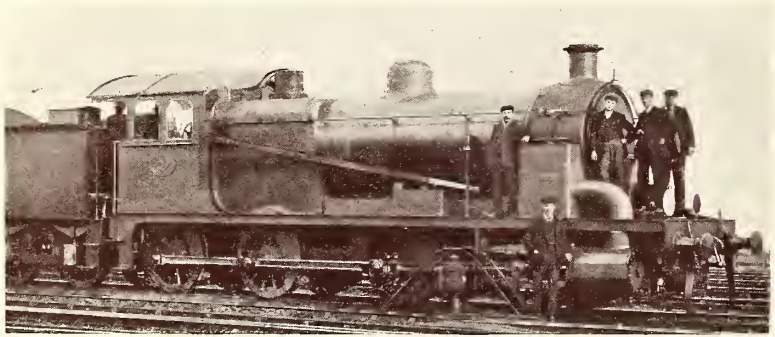
Working pressure, 180 lbs. per sq. in.

Weight on coupled wheels, 32 tons 17 cwts.; weight of engine in working order, 47 tons 15½ cwts.; weight of engine and tender in working order, with 2,640 gallons of water and 5 tons of coal, 78 tons 8 cwts.

Tractive force, 13,330 lbs.

Heating surface: Tubes, 1358·5 sq. ft.; firebox, 117·7 sq. ft.: total heating surface, 1476·2 sq. ft.

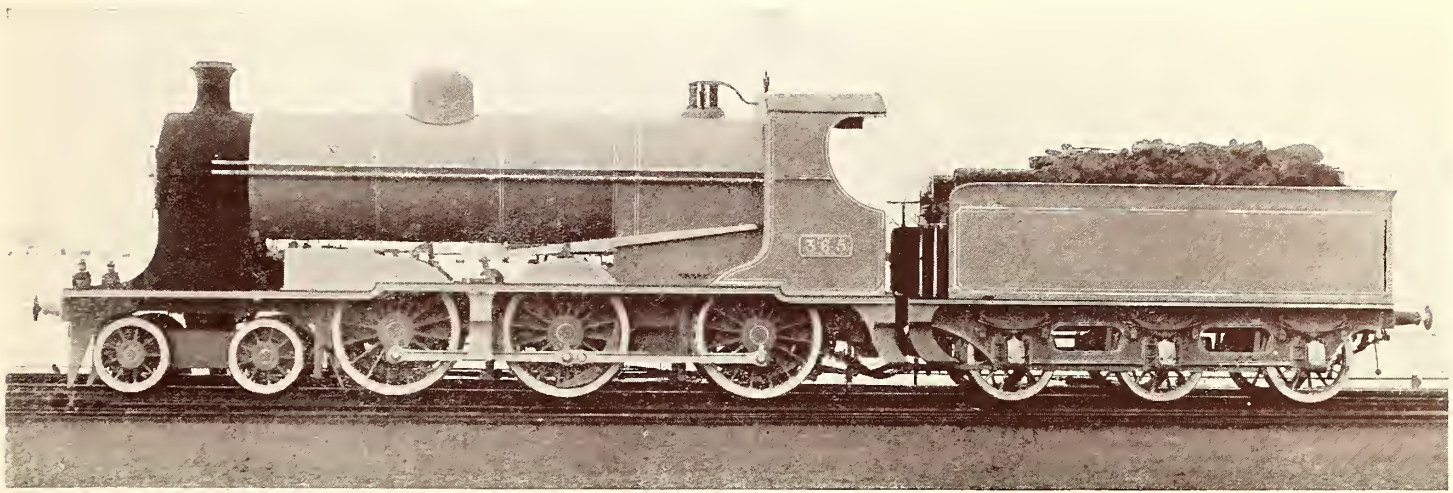
some very heavy and powerful 4—6—4 type tank locomotives. These, as need hardly be pointed out, are compounded on the de Glehn system, with the usual arrangement of the four cylinders, valve gearing, etc. They were built in the early part of 1906 by the Société Alsacienne de Constructions Mécaniques for the Eastern Railway, and are employed for dealing with heavy passenger and mixed traffic on hilly sections of the line. The Société Alsacienne are, at the time of writing, engaged in building, at the Belfort Works, a series of "Pacific" 4—6—2 type locomotives for the Paris-Orleans Railway. Besides being the first engines to have the 4—6—2 wheel arrangement on the Continent, they will be of very great size and weight, and will approach very nearly indeed to the maximum proportions allowable on the railways of France.



EIGHT-COUPLED GOODS LOCOMOTIVE, GREAT EASTERN RAILWAY.
(Converted from the "Decapod" Tank Engine of 1903.)
Cylinders, 18½ by 24 ins. Wheels, 4 ft. 6 ins. diameter. Total heating surface, 1,869 sq. ft. Grate area, 22·9 sq. ft. Working pressure, 180 lbs.

In the United States, the year 1906 was a more than usually interesting one, where locomotive engineering was concerned. To begin with, another "largest locomotive ever built" made its appearance—this time on the Great Northern Railway. The engine is a huge Mallet articulated compound, running on sixteen wheels, arranged on the 2—6—6—2 plan. It has a total heating surface of 5,658 sq. ft., a grate area of 78 sq. ft., a total weight in working order (with tender) of nearly 225 tons, and a tractive force of 71,600 lbs. when working compound. Apart from this specially notable locomotive, there were several important developments in American locomotive construction. Extended use was made of compounding and superheating, but neither has become established as yet as standard practice on any one line. The four-cylinder balanced compound made some headway, and, where it was possible to do so, increased proportions were employed for many types of engines.

The Northern Pacific Railway introduced seventy new engines about the middle of the year. They comprised 4—6—2, 2—8—2, and 2—6—2 types. One of the latter is shown on page 38. It has Walschaerts valve gear, a detail of construction which is coming into increased popularity in the United States. The whole of



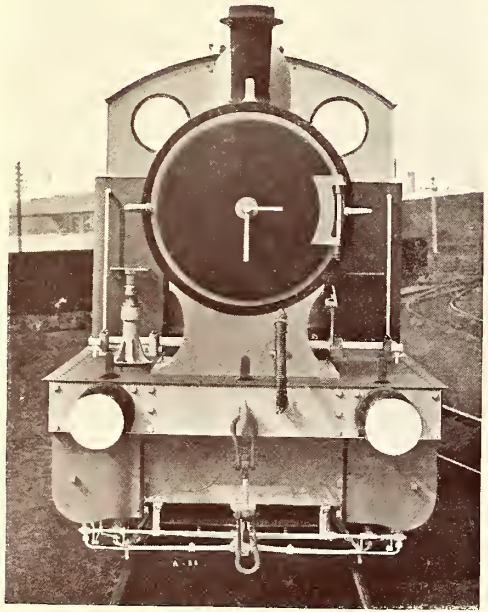
4—6—0 TYPE LOCOMOTIVE FOR FAST GOODS TRAFFIC, GREAT SOUTHERN AND WESTERN RAILWAY, IRELAND.
MR. ROBERT COEY, M.Inst.C.E., *Engineer*, INCHICHORE.

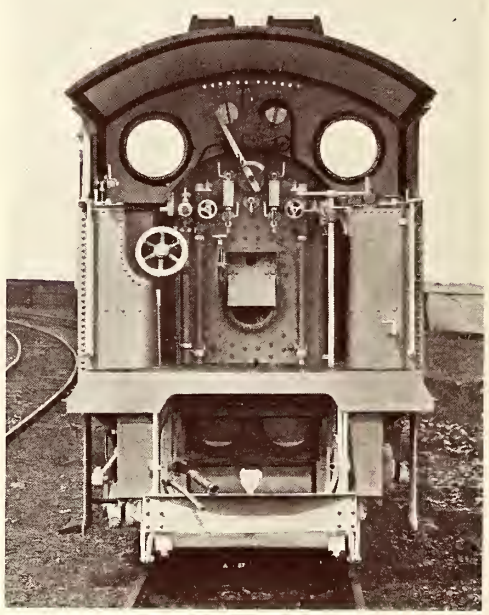
Leading Particulars.

Cylinders : Diameter, 19¼ ins. ; piston stroke, 26 ins.
Bogie wheels diameter, 3 ft.
Coupled wheels diameter, 5 ft. 1¾ ins.
Wheelbase : Bogie, 5 ft. 3 ins. ; coupled, 14 ft. 6 ins. ; total (engine) wheelbase, 24 ft. 10½ ins.
Boiler : Maximum diameter (outside), 4 ft. 11¾ ins. ; length between tube plates, 14 ft. 1¼ ins. ; centre height, 8 ft. 9 ins.
Grate area, 24·8 sq. ft.
Working pressure, 160 lbs. per sq. in.
Weight on coupled wheels, 44 tons 2 cwts. ; weight of engine in working order, 56 tons 19 cwts. ; weight of engine and tender in working order, with 3,340 gallons of water and 4 tons of coal, 91 tons 19 cwts.
Tractive force, 17,160 lbs.
Heating surface : Tubes, 1466·75 sq. ft. ; firebox, 133 sq. ft. : total heating surface, 1599·75 sq. ft.

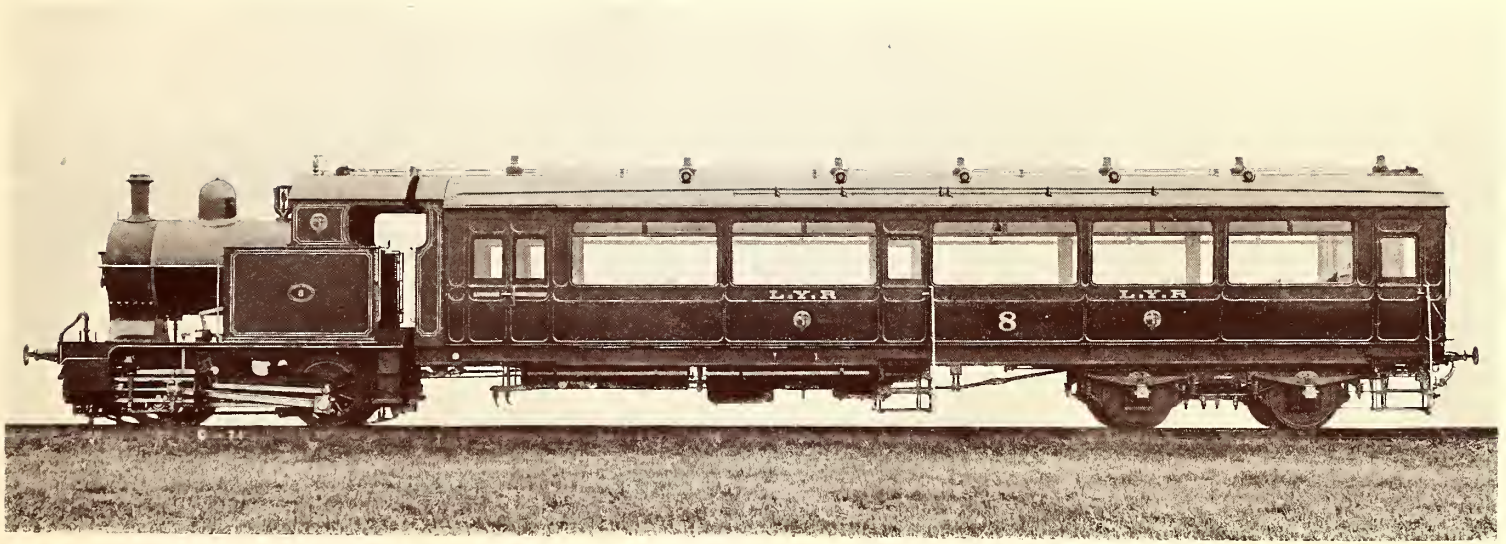
the seventy engines were fitted with combustion chamber boilers.

To sum up briefly the general tendencies of modern locomotive design as exemplified by the practice of 1906. There appears to be a decided movement in this country, and also upon the Continent, towards adopting very generally the "Atlantic" (4—4—2) type of engine for express, and the 4—6—0 type for the heaviest, passenger traffic. The latter type is also growing in favour for mixed traffic, the engines for this purpose having coupled wheels of reduced diameter. Larger tank and goods engines are being built, and locomotives of all descriptions are being called upon to haul increasingly heavy loads in order to reduce train mileage. Compounding, which has now become universal so far as Continental railways are concerned, has made some considerable progress in this country also. Superheating of steam for locomotives is one of the things which have not been taken up so thoroughly here as abroad, but it will have to be considered in the near future. Canada is taking a long lead in this matter, and both in Germany and America the question is being subjected to thorough investigation.





L.Y.R. RAIL MOTOR COACH—(Views of Engine Front and Cab.)



LATEST TYPE OF RAIL MOTOR-CAR, LANCASHIRE AND YORKSHIRE RAILWAY.
DESIGNED BY MR. GEO. HUGHES, M.Inst.C.E., *Locomotive Superintendent*, HORWICH.

Leading Particulars.

Engine : Cylinders, 12 ins. diameter by 16 ins. stroke.
Wheels, 3 ft. $7\frac{5}{8}$ ins. diameter on tread.
Wheelbase (engine), 8 ft. ; total wheelbase, 54 ft. 8 ins.
Boiler diameter, 4 ft. 3 ins.
Heating surface (total), 509 sq. ft.
Grate area, 9·4 sq. ft.
Working pressure, 180 lbs. per sq. in.
Capacity of water tank, 550 gallons ; capacity of coal bunker, 1 ton.
Car : Length over buffers, 69 ft. 5 ins. ; width of car body (outs.), 8 ft. $6\frac{3}{4}$ ins. ; length of car body, 47 ft. 6 ins. ; seating capacity, 56 passengers (all one class) ; luggage compartment, 340 cubic ft.
Total weight (complete), $47\frac{1}{2}$ tons.

The value of superheat is measured by the degree to which the temperature of the steam may safely be

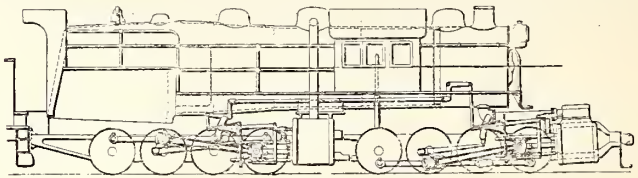
L.S.W.R. LOCOMOTIVE FOR RAIL MOTOR SERVICE.

raised, and, if the ordinary objections to highly superheated steam, including lubricating difficulties, can be successfully overcome, we may then surely begin to regard steam more in the character of a gaseous product, possessing qualities, as a prime mover, which are not as yet available.

A decided tendency was manifested during the past year towards adopting higher steam pressures, and the necessity of increasing as much as possible the area of heating and grate surfaces, so as to gain efficiency in the boiler, was recognised to the full and acted upon by locomotive engineers all over the world.

The Great Western Railway seems definitely committed to one marked feature of construction—viz., the coned boiler, which, by the way, no one else on this side shows themselves in any great hurry to imitate. Yet some really fine results are being obtained from it on the line of its adoption. The Belpaire firebox continued to forge rapidly ahead in favour, and three, if not four, British railways took it up during 1906. The use of the wide type of box was restricted to the Great Northern and London, Brighton and South Coast Railways.

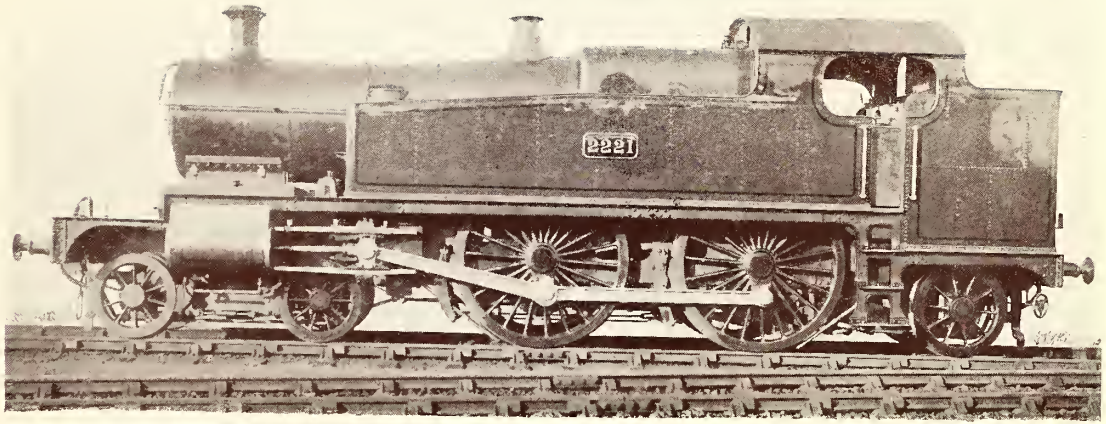
Mr. Drummond, on the London and South-Western, had no followers in his adherence to cross water-tubes



MALLET COMPOUND ARTICULATED LOCOMOTIVE (0—8—8—0 TYPE).
(Now building for the Erie Railroad, U.S.A.)

Cylinders, 25 and 39 ins. by 28 ins. stroke. Wheels, 4 ft. 3 ins. diameter.
Total wheelbase, 39 ft. 2 ins. Steam pressure, 215 lbs.

in the firebox. Although on many lines the maximum proportions permissible for locomotives under the



EXPRESS TANK LOCOMOTIVE (4—4—2 TYPE), GREAT WESTERN RAILWAY.

MR. G. JACKSON CHURCHWARD, M.INST.C.E., *Engineer*, SWINDON.

Leading Particulars.

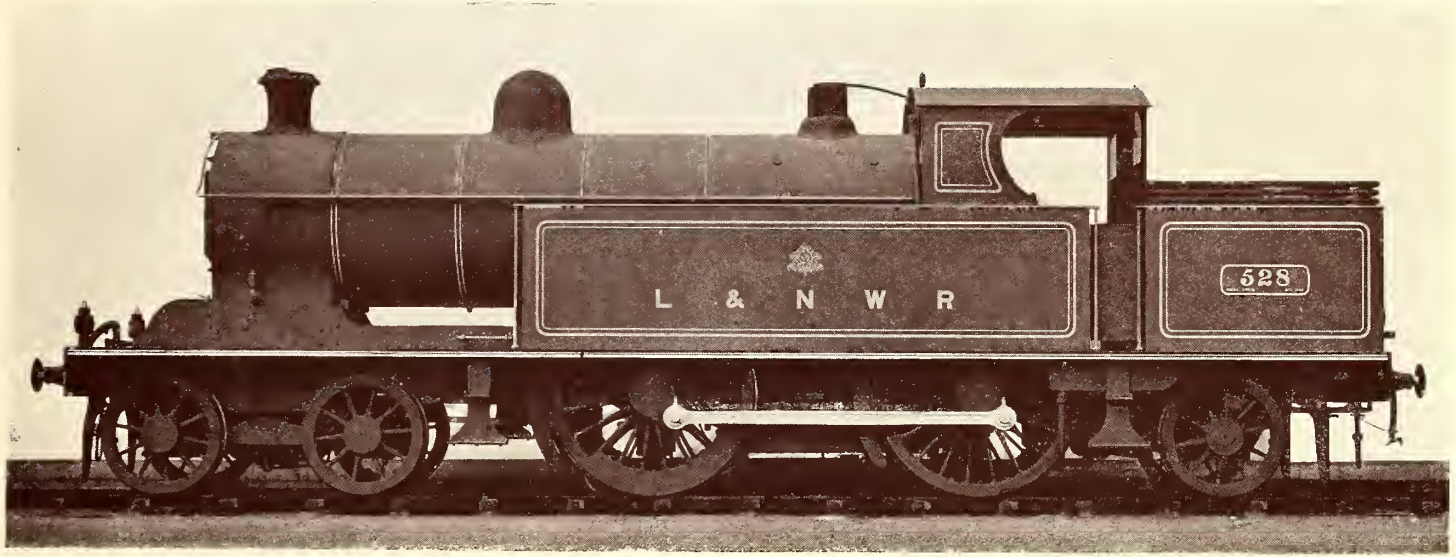
Cylinders: Diameter, 18 ins.; piston stroke, 30 ins.
Bogie wheels diameter, 3 ft. 2 ins.
Coupled wheels diameter, 6 ft. 8½ ins.
Radial wheels diameter, 3 ft. 8 ins.
Coupled wheelbase, 8 ft. 6 ins.; total wheelbase, 32 ft.
Boiler diameter (outside), 5 ft. 0½ in. at firebox; 4 ft. 5⅛ ins. at smokebox; length between tube plates, 11 ft. 4⅛ ins.
Heating surface: Tubes, 1369·58 sq. ft..; firebox, 121·31 sq. ft.: total, 1517·89 sq. ft.
Grate area, 20·35 sq. ft.
Working pressure, 195 lbs. per sq. in.
Weight on coupled wheels, 37 tons; total weight in working order, 75 tons.
Water capacity of tanks, 2,000 gallons; coal capacity of bunker, 3 tons.
Tractive force, 21,190 lbs.

restrictions of the British loading gauge have virtually been reached, there still remains much to be accomplished in the way of improving the steam locomotive. We may yet see this type of engine revolutionised before being abandoned. The year 1906 was not without its influence in this direction. What will follow?

Just at the time of going to press news comes from America that an even larger locomotive, of the "Mallet" articulated type, than that built by Baldwins for the Great Northern R.R. is on order for the Erie Railway. This remarkable locomotive weighs, in working order, no less than 183 tons, and with the tender 256 tons. The heating surface is 6,108 sq. ft., grate area 100 sq. ft., and tractive effort 98,000 lbs. The American Locomotive Company are the builders. An outline drawing of this engine appears on page 26.

A G.W.R. DE GLEHN COMPOUND AT WORK.

Photo by] *Mr. F. E. Mackay*



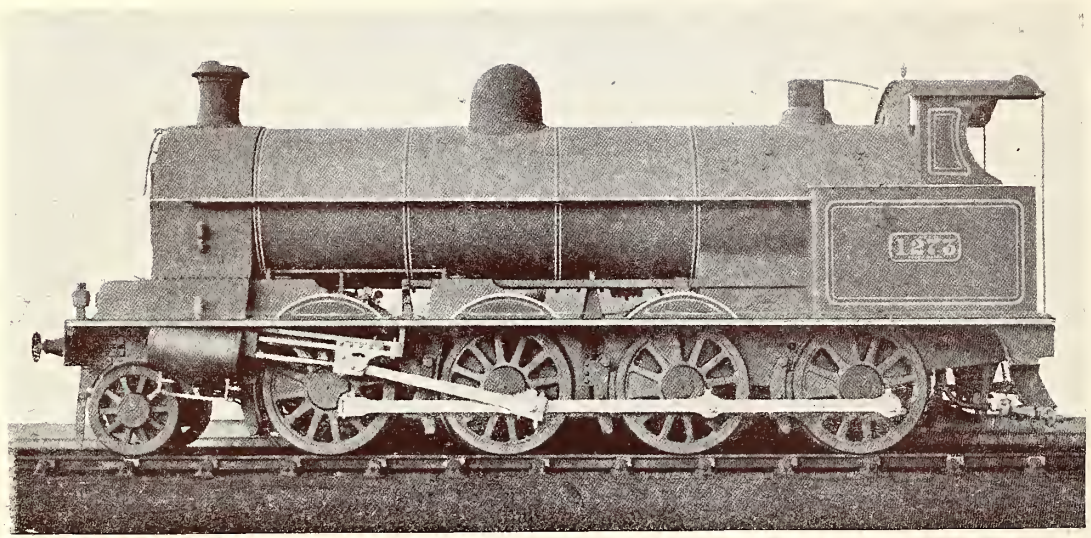
HEAVY PASSENGER TANK LOCOMOTIVE, LONDON AND NORTH-WESTERN RAILWAY.

MR. GEORGE WHALE, M.Inst.C.E., *Chief Mechanical Engineer*, CREWE.

Leading Particulars.

Cylinders : Diameter, 19 ins. ; piston stroke, 26 ins.
Bogie wheels, 3 ft. 9 ins. diameter.
Coupled wheels, 6 ft. 3 ins. diameter.
Trailing wheels, 3 ft. 9 ins. diameter.
Wheelbase : Coupled, 10 ft. ; total, 32 ft. $7\frac{1}{2}$ ins.
Boiler : Mean diameter (outside), 5 ft. $0\frac{3}{4}$ in. ; length, 11 ft. $7\frac{7}{8}$ ins. ; height of centre, 8 ft. 7 ins.

Heating surface : Tubes, 1777·5 sq. ft. ; firebox, 161·5 sq. ft. : total heating surface, 1,939 sq. ft.
Grate area, 22·4 sq. ft.
Working pressure, 175 lbs. per sq. in.
Weight on coupled wheels, $39\frac{1}{2}$ tons ; weight in full working order, $74\frac{3}{4}$ tons.
Tractive force, 17,080 lbs.



FOUR-CYLINDER WEBB SYSTEM COMPOUND MINERAL ENGINE, LONDON AND NORTH-WESTERN RAILWAY.

CONVERTED IN 1906 FROM 0—8—0 TO 2—8—0 TYPE BY MR. GEORGE WHALE, M.Inst.C.E., *Chief Mechanical Engineer*, CREWE.

Leading Particulars.

Cylinders : H.-P. (2), outside, 16 ins. diameter ; L.-P. (2), inside, 20½ ins. diameter ; piston stroke, 24 ins.
Leading truck wheels diameter, 3 ft.
Coupled wheels diameter, 4 ft. 5½ ins.
Coupled wheelbase, 17 ft. 3 ins. ; total (engine) wheelbase, 23 ft. 7 ins.
Boiler : Mean diameter (outside), 5 ft. 0¾ in. ; length 14 ft. 6 ins.
Heating surface : Tubes, 2,034 sq. ft. ; firebox, 146·6 sq. ft. ; total heating surface, 2180·6 sq. ft.
Grate area, 23·6 sq. ft.
Working pressure, 200 lbs. per sq. in.
Weight on coupled wheels, 52 tons 10 cwts. ; weight of engine in working order, 62 tons 10 cwts. ; weight of engine and tender in working order with 3,000 gallons of water and 6 tons of coal, 99 tons 10 cwts.
Tractive force, 24 700 lbs.

EIGHT WHEELS COUPLED (0—8—0 TYPE) MINERAL LOCOMOTIVE, LONDON AND NORTH-WESTERN RAILWAY.

CONVERTED IN 1906 FROM THREE-CYLINDER WEBB SYSTEM COMPOUND TO TWO-CYLINDER SIMPLE ENGINE BY MR. GEORGE WHALE, M.Inst.C.E., *Chief Mechanical Engineer*, CREWE.

Leading Particulars.

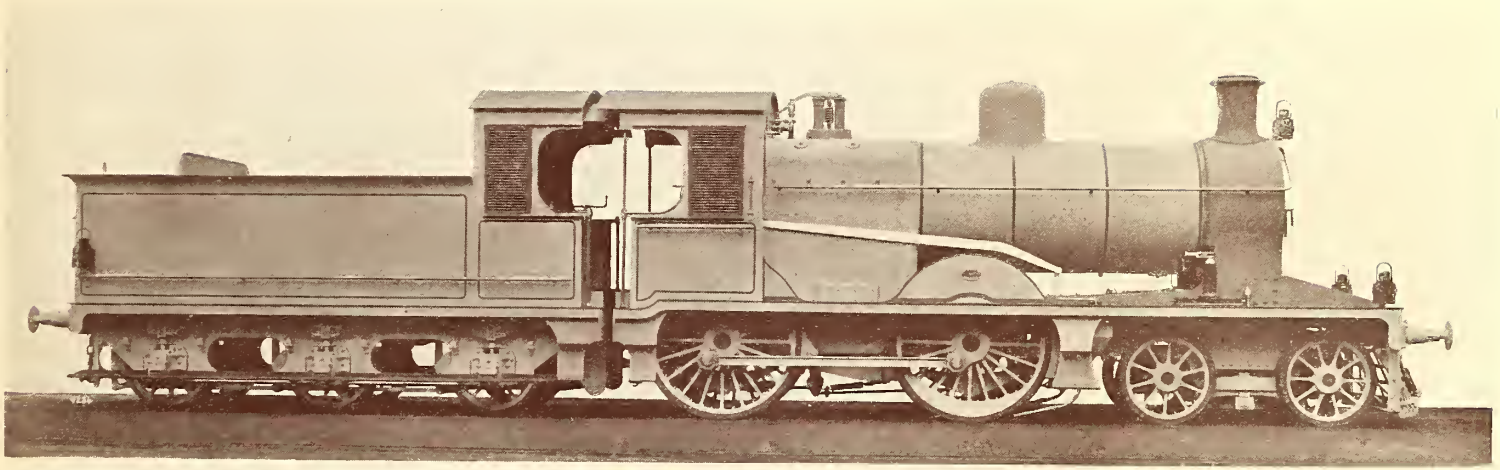
Cylinders : Diameter, 19½ ins. ; piston stroke, 24 ins.
Wheels diameter, 4 ft. 5½ ins.
Wheelbase, 17 ft. 3 ins.
Boiler : Mean diameter (outside), 5 ft. 0¾ in. ; length, 14 ft. 6 ins.
Heating surface : Tubes, 2,034 sq. ft. ; firebox, 146·6 sq. ft. : total heating surface, 2180·6 sq. ft.
Grate area, 23·6 sq. ft.
Working pressure, 175 lbs. per sq. in.
Weight of engine in working order, 56 tons 5 cwts. ; weight of engine and tender with 3,000 gallons of water and 6 tons of coal, 93 tons 5 cwts.
Tractive force, 23,280 lbs.

SIX WHEELS COUPLED (0—6—0 TYPE) GOODS LOCOMOTIVE, LONDON, BRIGHTON AND SOUTH COAST RAILWAY.

MR. D. EARLE MARSH, M.Inst.C.E., *Engineer*, BRIGHTON.

Leading Particulars.

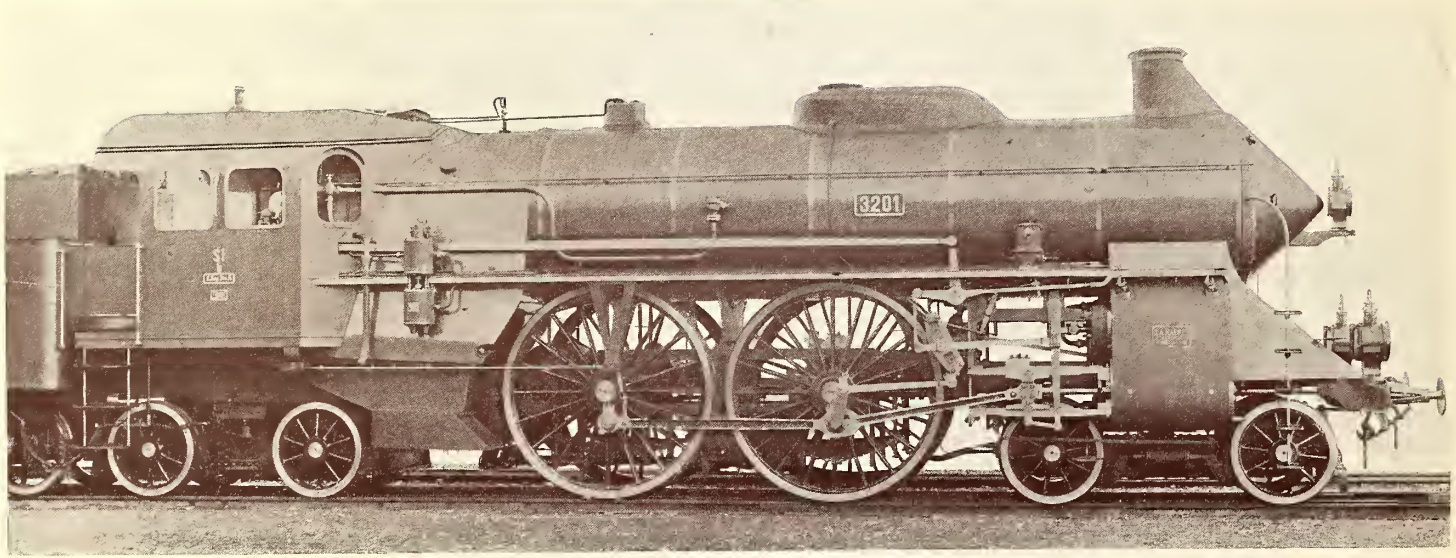
Cylinders : Diameter, 17½ ins. ; piston stroke, 26 ins.
Wheels diameter, 5 ft.
Engine wheelbase, 15 ft. 3 ins.
Boiler : Diameter (outside second ring), 5 ft. ; length of barrel, 10 ft. 10¼ ins.
Heating surface : Tubes, 1183·41 sq. ft. ; firebox, 101·27 sq. ft. : total heating surface, 1284·68 sq. ft.
Grate area, 18·64 sq. ft.
Working pressure, 170 lbs. per sq. in.
Weight of engine in working order, 49½ tons ; weight of engine and tender in working order, with 3,112 gallons of water and 4 tons of coal, 76 tons 14 cwts.
Tractive force, 20,701 lbs.



STANDARD 4—4—0 TYPE PASSENGER LOCOMOTIVE FOR THE 5 FT. 6 INS. GAUGE, NORTH-WESTERN RAILWAY OF INDIA.
BUILT BY MESSRS. BEYER, PEACOCK & CO., LTD., GORTON, NEAR MANCHESTER.
(This design conforms to the recommendations of the Engineering Standards Committee.)

Leading Particulars.

Cylinders : Diameter, 18½ ins. ; piston stroke, 26 ins.
Bogie wheels diameter, 3 ft. 7 ins.
Coupled wheels diameter, 6 ft. 2 ins.
Wheelbase : Bogie, 6 ft. ; coupled, 9 ft. 6 ins. ; total (engine) wheelbase, 22 ft. 11 ins.
Boiler : Maximum diameter (outside), 4 ft. 8½ ins. ; length between tube plates, 11 ft. 4 ins.
Heating surface : Tubes, 1229·5 sq. ft. ; firebox, 120 sq. ft. : total heating surface, 1349·5 sq. ft.
Grate area, 25·3 sq. ft.
Working pressure, 180 lbs. per sq. in.
Weight on coupled wheels, 30 tons 19 cwts. 1 qr. ; weight of engine in working order, 49 tons 16 cwts. 1 qr.
Capacity of tender : For water, 3,000 gallons ; for coal, 7½ tons.
Total weight of engine and tender in working order, 90 tons 2 cwts.
Tractive force per lb. of M.E.P. in cylinders, 121·9 lbs.



FOUR-CYLINDER COMPOUND EXPRESS PASSENGER LOCOMOTIVE, BAVARIAN STATE RAILWAYS.

SPECIALLY DESIGNED FOR HIGH-SPEED SERVICE AND BUILT BY J. A. MAFFEI, OF MUNICH.

Leading Particulars.

Cylinders: H.-P. (2), diameter, 16⅛ ins.; L.-P. (2), diameter, 24 ins.; piston stroke, 25¼ ins.
Bogie wheels diameter, 3 ft. 3⅝ ins.
Coupled wheels diameter, 7 ft. 2½ ins.
Rigid wheelbase, 7 ft. 7 ins.
Total engine wheelbase, 38 ft. 4½ ins.
Boiler: Diameter outside, 5 ft. 8⅛ ins.; length between tube plates, 16 ft. 1 in.; centre height, 9 ft. 10 ins.
Heating surface: Tubes, 2141·24 sq. ft.; firebox, 177·54 sq. ft.; superheater, 403·50 sq. ft.: total heating surface, 2722·28 sq. ft.
Grate area, 50·5 sq. ft.
Working pressure, 205·8 lbs. per sq. in.
Weight on coupled wheels, 32 tons; weight of engine in working order, 82 tons; engine and tender in working order, with 5,800 gallons of water and 7 tons of coal, 135 tons 10 cwts.
Tractive force, 11,000 lbs.

FOUR-CYLINDER COMPOUND EXPRESS PASSENGER LOCOMOTIVE (4—4—2 TYPE), HUNGARIAN STATE RAILWAYS.
CONSTRUCTED AT THE STATE RAILWAYS LOCOMOTIVE WORKS, BUDA-PESTH.

Leading Particulars.

Cylinders: H.-P. (2), diameter, 14⅛ ins.; L.-P. (2), diameter, 24⅜ ins.; piston stroke, 26 ins.

Bogie wheels diameter, 3 ft. 5 ins.

Coupled wheels diameter, 6 ft. 10⅝ ins.

Trailing wheels diameter, 4 ft.

Wheelbase: Coupled, 7 ft. 2½ ins.; total (engine), 32 ft. 1 in.

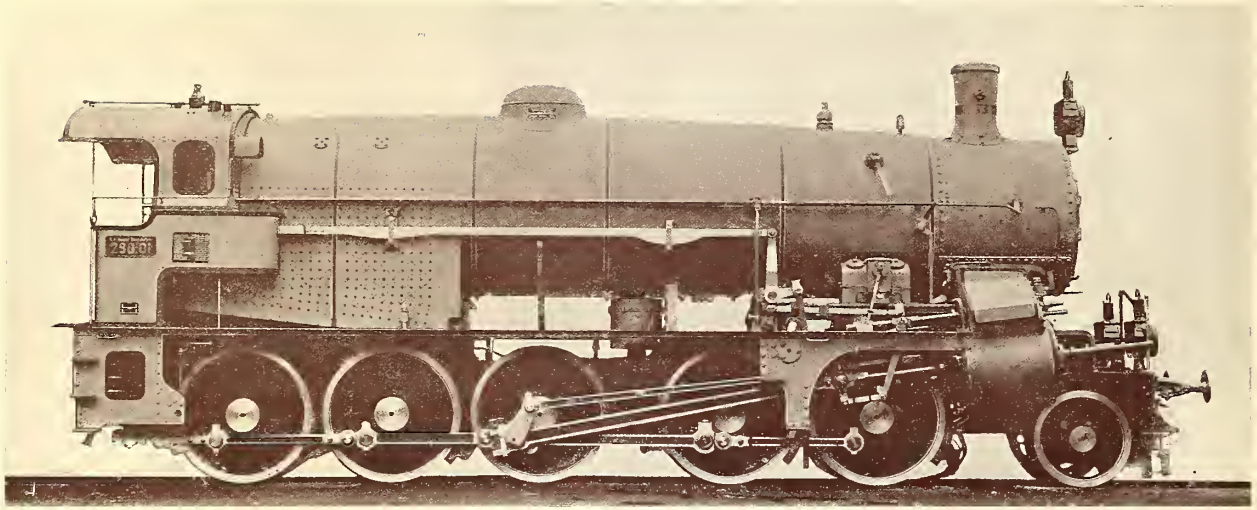
Boiler: Diameter inside, 5 ft. 2 ins.; length between tube plates, 17 ft. 6 ins.

Heating surface: Tubes, 2,687 sq. ft.; firebox, 136 sq. ft.: total heating surface, 2,823 sq. ft.

Grate area, 41·90 sq. ft.

Working steam pressure, 228 lbs. per sq. in.

Weight on coupled wheels, 31 tons 11 cwts.; weight of engine in working order, 74 tons 5 cwts.; weight of engine and tender in working order with 4,000 gallons of water and 8 tons of coal, 121 tons 4 cwts.



FOUR-CYLINDER COMPOUND LOCOMOTIVE, AUSTRIAN STATE RAILWAYS (GOLSDORF SYSTEM).
CONSTRUCTED AT THE LOCOMOTIVE WORKS OF THE AUSTRO-HUNGARIAN STATE RAILWAY COMPANY, VIENNA.

Leading Particulars.

Cylinders : H.-P. (2), diameter, 14½ ins. ; L.-P. (2), diameter, 24¾ ins. ; piston stroke, 28¼ ins.

Truck wheels diameter, 3 ft. 4¾ ins.

Coupled wheels diameter, 4 ft. 9 ins.

Wheelbase : Rigid, 16 ft. 5 ins. ; total (engine), 28 ft. 5 ins.

Boiler : Maximum diameter (outside), 5 ft. 10⅞ ins. ; length over tube plates, 16 ft. 4¾ ins.

Heating surface : Tubes, 1939·19 sq. ft. ; firebox, 166·84 sq. ft. ; superheater surface, 678·15 sq. ft. : total heating surface, 2777·18 sq. ft.

Grate area, 49½ sq. ft.

Working pressure, 235 lbs. per sq. in.

Weight on coupled wheels, 67 tons 10 cwts. ; weight of engine in working order, 77 tons 2 cwts.

FOUR-CYLINDER COMPOUND (4—6—4 TYPE) TANK LOCOMOTIVE (DE GLEHN'S SYSTEM), EASTERN RAILWAY OF FRANCE.

DESIGNED BY MONS. L. SALAMON, *Chief Mechanical Engineer*, AND BUILT AT THE BELFORT WORKS OF THE SOCIÉTÉ ALSACIENNE DE CONSTRUCTIONS MÉCANIQUES.

Leading Particulars.

Cylinders: H.-P. (2), 14 ins. diameter; L.-P. (2), 22 ins.; piston stroke, 25¼ ins.

Bogie wheels diameter, 2 ft. 10 ins.

Coupled wheels diameter, 5 ft. 3½ ins.

Wheelbase: Bogie, 6 ft.; coupled, 13 ft.; total wheelbase, 36 ft.

Boiler: Mean diameter (outside), 5 ft.; length over tube plates, 14 ft.

Heating surface: Tubes, 1432·6 sq. ft.; firebox, 150·7 sq. ft.: total heating surface, 1582·13 sq. ft.

Grate area, 26 sq. ft.

Steam pressure, 225 lbs. per sq. in.

Weight in working order, 88 tons 15 cwts.

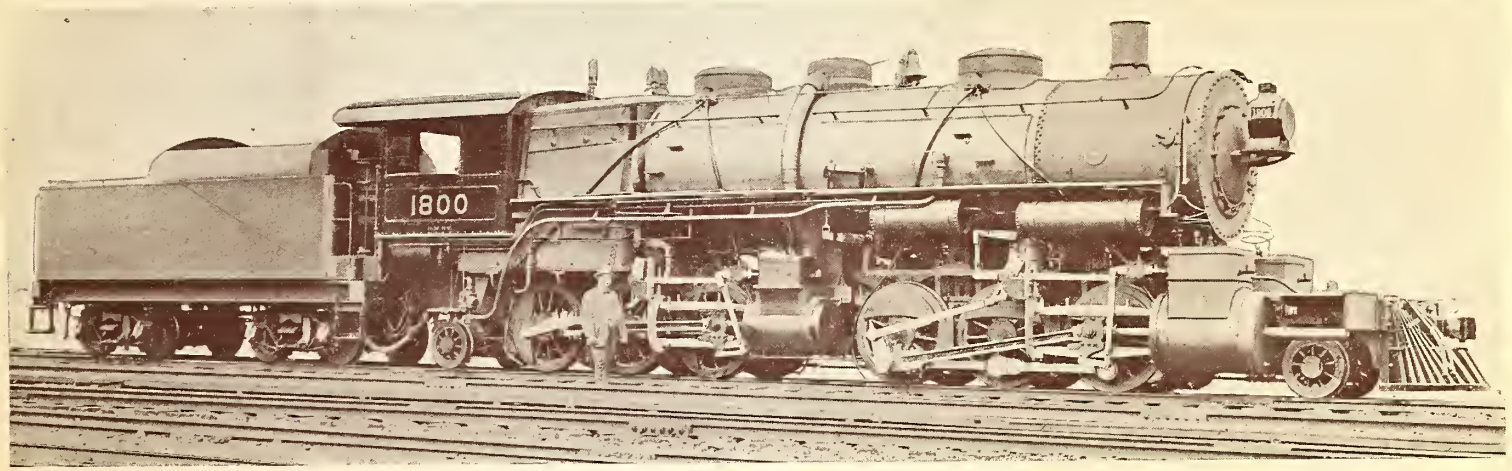
MIXED TRAFFIC LOCOMOTIVE (2—6—2 TYPE), NORTHERN PACIFIC RAILROAD.

(With Combustion Chamber Boiler and Walschaerts' Valve Gear.)

Built at the American Locomotive Company's Brooks Works.

Leading Particulars.

Cylinders, 21 ins. diameter by 28 ins. stroke.
Leading truck wheels, 2 ft. 9½ ins. diameter.
Coupled wheels, 5 ft. 3 ins. diameter.
Trailing wheels, 3 ft. 9 ins. diameter.
Wheelbase: Coupled, 11 ft.; total (engine) wheelbase, 28 ft. 11 ins.
Boiler: Height of centre from rails, 9 ft. 8 ins.; outside diameter (first ring), 6 ft. 0⅛ in.; length over tube plates, 13 ft. 3 ins.
Heating surface: Tubes, 2,105 sq. ft.; firebox, 226 sq. ft.; arch tubes, 9 sq. ft.: total heating surface, 2,340 sq. ft.
Grate area, 43·5 sq. ft.
Working pressure, 200 lbs.
Weight on coupled wheels, 66 tons 10 cwts.; weight of engine in working order, 90 tons 16 cwts.
Total weight, engine and tender in working order, 157 tons 6 cwts.
Tractive power of engine, 33,300 lbs.



"THE LARGEST LOCOMOTIVE IN THE WORLD."*
MALLET COMPOUND ARTICULATED (2—6—6—2 TYPE) ENGINE, GREAT NORTHERN RAILWAY, U.S.A.
BUILT AT THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA.

Leading Particulars.

Cylinders: H.-P. (2), diameter, 21½ ins.; L.-P. (2), 33 ins.; piston stroke, 32 ins.
Truck wheels diameter, 2 ft. 6 ins.
Coupled wheels diameter, 4 ft. 7 ins.
Wheelbase: Coupled (each group), 10 ft.; total engine wheelbase, 44 ft. 10 ins.
Boiler: Diameter (outside), 7 ft.; length over tube plates, 21 ft.
Heating surface: Tubes, 5,433 sq. ft.; firebox, 225 sq. ft.: total, 5,658 sq. ft.
Grate area, 78 sq. ft.; working pressure, 200 lbs.
Weight on twelve coupled wheels, 141 tons; weight of engine in working order, 158 tons 9 cwts.; weight of engine and tender in working order, with 8,000 gallons of water and 13 tons of coal, 224 tons 17 cwts.
Tractive power, working compound, 71,600 lbs.

(* *The* 0—8—8—0 *engine building at the end of* 1906 *for the Erie R.R. will have still larger dimensions.*)

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